

APRIL/MAY 2024

DMA42/GMA42 — FLUID DYNAMICS

18. A three dimensional doublet of strength μ whose axis is in the direction OX is distant ' a ' from the rigid plane $x = 0$ which is the sole boundary of liquid of density ρ , infinite in extent. Find the pressure at a point on the boundary distant ' r ' from the doublet given that the pressure at ∞ is p_∞ . Show that the pressure on the plane is least

at a distance $a\sqrt{\frac{5}{2}}$ from the doublet.

19. A cylinder of infinite length nearly circular section moves through an infinite volume of liquid with a velocity U at right-angles to its axis and in the direction of x - axis. If its section is specified by the equation $R = a(1 + \varepsilon \cos n\theta)$, where ε is small, show that the approximate value of the velocity potential is

$$Ua \left\{ \frac{a}{R} \cos \theta + \varepsilon \left(\frac{a}{R} \right)^{n+1} \cos(n+1)\theta - \varepsilon \left(\frac{a}{R} \right)^{n-1} \cos(n-1)\theta \right\}$$

20. Derive Navier stokes equation of motion of a fluid.

Time : Three hours

Maximum : 75 marks

SECTION A — (10 × 2 = 20 marks)

Answer ALL questions.

1. Define Real fluid and ideal fluid.
2. Show that the $\vec{q} = [-\omega y, \omega x, 0]$, ($\omega = \text{constant}$) is not of the potential kind.
3. Define Pitot tube and Venturi tube.
4. Define Beltrami vector.
5. Define simple sources.
6. Write the vector moment of the doublet.
7. State Milne-Thomson circle theorem.
8. Define Magnus effect.
9. What is stress tensor?
10. Define principal stress.



SECTION B — ($5 \times 5 = 25$ marks)

Answer ALL questions.

11. (a) Derive the acceleration of fluid particle.

Or

- (b) Derive the equation of continuity.

12. (a) A long pipe is of length l and has slowly tapering cross-section. It is inclined at angle α to the horizontal and water flows steadily through it from the upper to the lower end. The section at the upper end has twice the radius of the lower end. At the lower end, the water is delivered at atmospheric pressure. If the pressure at the upper end is twice atmospheric, find the velocity of delivery.

Or

- (b) Derive the Bernoulli's equation.

13. (a) Find the velocity potential due to the doublet at 'o'.

Or

- (b) Discuss doublet in a uniform stream.

14. (a) Discuss the flow for which $\omega = z^2$.

Or

- (b) Find the equation of the streamlines due to a uniform line sources of strength m through the points $A(-c, 0)$ and $B(c, 0)$ and a uniform line sink of strength $2m$ through the origin.

15. (a) Derive the translational motion of fluid element.

Or

- (b) Express the six distinct components of the stress matrix of the principal stresses.

SECTION C — ($3 \times 10 = 30$ marks)

Answer any THREE questions.

16. At a point in an incompressible fluid having spherical polar coordinates (r, θ, ψ) , the velocity components are $[2Mr^{-3} \cos \theta, Mr^{-3} \sin \theta, 0]$, where M is a constant.

- (a) Show that the velocity of the potential kind.
(b) Find the velocity potential and the equation of the stream line.

17. Derive the Euler's equation of motion.